2011 Mississippi Curriculum Framework

Postsecondary Automation and Control Technology

(Program CIP: 15.0613 – Manufacturing Technology/Technician)

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Standards in this document are based on information from the following organizations:

International Technology and Engineering Educators Association Standards for Technological Literacy	International Technology and Engineering Educators Association (ITEEA) STL Content Standards
Related Academic Standards	CTB/McGraw-Hill LLC. (2005). *Tests of adult basic education, Forms 9 and 10.* Monterey, CA: Author. Reproduced with permission of CTB/McGraw-Hill LLC. TABE is a registered trademark of The McGraw-Hill Companies, Inc. Copyright © 2005 by CTB/McGraw-Hill LLC. Reproduction of this material is permitted for educational purposes only.
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Preface

Postsecondary Automation and Control Technology Research Synopsis

Articles, books, Web sites, and other materials listed at the end of each course were considered during the revision process. *Physics in Context* and *Leading and Learning with Technology* were especially useful in providing insight into trends and issues in the field. These references are suggested for use by instructors and students during the study of the topics outlined.

Industry advisory team members from colleges throughout the state were asked to give input related to changes to be made to the curriculum framework. Instructors from colleges throughout the state were also asked to give input on changes to be made to the curriculum framework. Changes suggested for the curriculum included removing the Calibration and Measurement Principles course and increasing the robotics software and technology.

Curriculum

The following national standards were referenced in each course of the curriculum:

- CTB/McGraw-Hill LLC *Tests of Adult Basic Education*
- *21st Century Skills*
- *International Technology Education Association Standards for Technological Literacy*

Needs of the Future Workforce

The Automation and Control Technician occupation is projected to have modest growth in the United States, 9 percent, over the projection decade, 2010 through 2020. However the occupation is projected to grow much faster than ever in Mississippi, 24 percent. Job prospects will be best for workers with a combination of education from a technical or postsecondary programs and work experience.

Automation and Control Technology Employment Projections and Earnings

Region	2010 Jobs	2020 Jobs	Change	% Change	Openings	2010 Median Hourly Earnings
Regional Total	1,198	1,486	288	24%	562	$17.22
National Total	193,108	210,535	17,427	9%	63,515	$18.53

Source: EMSI Complete Employment - 1st Quarter 2011

Industry and instructor comments, along with current research, were considered by the curriculum revision team during the revision process; changes were made as needed and appropriate. Many of the skills and topics noted in the research were already included in the curriculum framework. Specific changes made to the curriculum at the curriculum revision meeting included:

- Competencies and objectives were reviewed to ensure accuracy and appropriateness.
- The Recommended Tools and Equipment list was updated.

Assessment

Students will be assessed using the Automation and Control Technology MS-CPAS2 test. The MS-CPAS2 blueprint can be found at http://www.rcu.msstate.edu/. All students will test after year one of their program. A second test covering the second year material will be administered

to AAS track students upon completion of their program. If there are questions regarding assessment of this program, please contact the STEM Instructional Design Specialist at the Research and Curriculum Unit at 662.325.2510.

There are no alternate assessments at this time.

Professional Learning
It is suggested that instructors participate in professional learning related to the following concepts:

- Differentiated instruction – To learn more about differentiated instruction, please go to http://www.paec.org/teacher2teacher/additional_subjects.html and click on Differentiated Instruction. Work through this online course and review the additional resources.

Program Exceptions
No program exceptions exist at this time.

Foreword

As the world economy continues to evolve, businesses and industries must adopt new practices and processes in order to survive. Quality and cost control, work teams and participatory management, and an infusion of technology are transforming the way people work and do business. Employees are now expected to read, write, and communicate effectively; think creatively, solve problems, and make decisions; and interact with each other and the technologies in the workplace. Career–technical programs must also adopt these practices in order to provide graduates who can enter and advance in the changing work world.

The curriculum framework in this document reflects these changes in the workplace and a number of other factors that impact local career–technical programs. Federal and state legislation calls for articulation between high school and community college programs, integration of academic and career skills, and the development of sequential courses of study that provide students with the optimum educational path for achieving successful employment. National skills standards, developed by industry groups and sponsored by the U.S. Department of Education and Labor, provide career and technical educators with the expectations of employers across the United States. All of these factors are reflected in the framework found in this document.

Referenced throughout the courses of the curriculum are the 21st Century Skills, which were developed by the Partnership for 21st Century Skills, a group of business and education organizations concerned about the gap between the knowledge and skills learned in school and those needed in communities and the workplace. A portion of the 21st Century Skills addresses learning skills needed in the 21st century, including information and communication skills, thinking and problem-solving skills, and interpersonal and self-directional skills. Another important aspect of learning and working in the 21st century involves technology skills. The International Society for Technology in Education, developer of the National Educational Technology Standards (NETS), was a strategic partner in the Partnership for 21st Century Skills.

Each postsecondary program of instruction consists of a program description and a suggested sequence of courses that focus on the development of occupational competencies. The MS-CPAS2 blueprints are based upon the suggested course sequences to allow for year 1 and year 2 assessments for all exit options. Please refer to the blueprint online. Each career–technical course in this sequence has been written using a common format, which includes the following components:

- Course Name – A common name that will be used by all community and junior colleges in reporting students

- Course Abbreviation – A common abbreviation that will be used by all community and junior colleges in reporting students

- Classification – Courses may be classified as the following:
    - Career–technical core – A required career–technical course for all students
    - Area of concentration (AOC) core – A course required in an area of concentration of a cluster of programs
    - Career–technical elective – An elective career–technical course
    - Related academic course – An academic course that provides academic skills and knowledge directly related to the program area

  - Academic core – An academic course that is required as part of the requirements for an associate's degree

- Description – A short narrative that includes the major purpose(s) of the course and the recommended number of hours of lecture and laboratory activities to be conducted each week during a regular semester

- Prerequisites – A listing of any courses that must be taken prior to or on enrollment in the course

- Corequisites – A listing of courses that may be taken while enrolled in the course

- Competencies and Suggested Objectives – A listing of the competencies (major concepts and performances) and the suggested student objectives that will enable students to demonstrate mastery of these competencies

The following guidelines were used in developing the program(s) in this document and should be considered in compiling and revising course syllabi and daily lesson plans at the local level:

- The content of the courses in this document reflects approximately 75% of the time allocated to each course. The remaining 25% of each course should be developed at the local district level and may reflect the following:
  - Additional competencies and objectives within the course related to topics not found in the state framework, including activities related to specific needs of industries in the community college district
  - Activities that develop a higher level of mastery on the existing competencies and suggested objectives
  - Activities and instruction related to new technologies and concepts that were not prevalent at the time the current framework was developed or revised
  - Activities that include integration of academic and career–technical skills and course work, school-to-work transition activities, and articulation of secondary and postsecondary career–technical programs
  - Individualized learning activities, including work-site learning activities, to better prepare individuals in the courses for their chosen occupational areas

- Sequencing of the course within a program is left to the discretion of the local district. Naturally, foundation courses related to topics such as safety, tool and equipment usage, and other fundamental skills should be taught first. Other courses related to specific skill areas and related academics, however, may be sequenced to take advantage of seasonal and climatic conditions, resources located outside of the school, and other factors.

- Programs that offer an Associate of Applied Science degree must include a minimum 15-semester-credit-hour academic core. Specific courses to be taken within this core are to be determined by the local district. Minimum academic core courses are as follows:
  - 3 semester credit hours (sch) Math/Science Elective
  - 3 semester credit hours Written Communications Elective
  - 3 semester credit hours Oral Communications Elective
  - 3 semester credit hours Humanities/Fine Arts Elective

- 3 semester credit hours Social/Behavioral Science Elective

It is recommended that courses in the academic core be spaced out over the entire length of the program, so that students complete some academic and career–technical courses each semester. Each community or junior college has the discretion to select the actual courses that are required to meet this academic core requirement.

- Career–technical elective courses have been included to allow community colleges and students to customize programs to meet the needs of industries and employers in their area.

In order to provide flexibility within the districts, individual courses within a framework may be customized by doing the following:

- Adding new competencies and suggested objectives
- Revising or extending the suggested objectives for individual competencies
- Adjusting the semester credit hours of a course to be up 1 hour or down 1 hour (after informing the Mississippi Community College Board [MCCB] of the change)

In addition, the curriculum framework as a whole may be customized by doing the following:

- Resequencing courses within the suggested course sequence reflecting the new assessment format
- Developing and adding a new course that meets specific needs of industries and other clients in the community or junior college district (with MCCB approval)
- Utilizing the career technical elective options in many of the curricula to customize programs

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Program Description

Automation and Control Technology is an instructional program that provides the student with technical knowledge and skills necessary for gaining employment as an automated manufacturing systems technician in maintenance diagnostics, engineering, or production in an automated manufacturing environment. The focus of this program is on electricity/electronics, fluid power, motors and controllers, programmable controls, interfacing techniques, instrumentation, and automated processes.

This curriculum is designed as a two-year technical program. The Associate of Applied Science Degree in Automation and Control Technology will be awarded at the culmination of a minimum of 64 semester hours of satisfactory study. Graduates of the program will be qualified to seek employment as entry level electronics, instrumentation, robotics, automation, and maintenance technicians. Students who graduate from the program will also better prepared to continue their education in advanced engineering related fields.

Industry standards referenced are from the International Technology and Engineering Educators Association (ITEEA) STL Content Standards.

Suggested Course Sequence*
Automation and Control Technology
Career Certificate

2 sch	Introduction to Automation and Controls (MFT 1112)
4 sch	DC Circuits (EET 1114)
4 sch	Digital Electronics (EET 1214)
3 sch	Approved Technical Elective
3 sch	Technical Elective
16 sch	

3 sch	AC Circuits (EET 1123)
4 sch	Solid State Devices and Circuits (EET 1334)
3 sch	Motor Control Systems (ELT 1413)
4 sch	Fluid Power (INT 1214)
3 sch	Electrical Wiring for Automation and Control Technology (MFT 1123)***
17 sch	

Suggested Course Sequence*
Automation and Control Technology
Technical Certificate

2 sch	Introduction to Automation and Controls (MFT 1112)
4 sch	DC Circuits (EET 1114)
4 sch	Digital Electronics (EET 1214)
3 sch	Approved Technical Elective
3 sch	Technical Elective
16 sch	

3 sch	AC Circuits (EET 1123)
4 sch	Solid State Devices and Circuits (EET 1334)
3 sch	Motor Control Systems (ELT 1413)
4 sch	Fluid Power (INT 1214)
14 sch	

3 sch	Programmable Logic Controllers (ELT 2613)
4 sch	Control Systems I (INT 2114)
3 sch	Approved Technical Elective
3 sch	Technical Elective
13 sch	

3 sch	Electrical Wiring for Automation and Control Technology (MFT 1123)***
4 sch	Approved Technical Elective
3 sch	Technical Elective
3 sch	Technical Elective
13 sch	

Suggested Course Sequence*
Automation and Control Technology
Associate of Applied Science Degree

FIRST YEAR

2 sch	Introduction to Automation and Controls (MFT 1112)	3 sch	AC Circuits (EET 1123)
4 sch	DC Circuits (EET 1114)	4 sch	Solid State Devices and Circuits (EET 1334)
3 sch	Math/Science Elective**	3 sch	Motor Control Systems (ELT 1413)
3 sch	Computer Related Elective	4 sch	Fluid Power (INT 1214)
3 sch	Technical Elective	3 sch	Written Communications Elective
15 sch		17 sch	

SECOND YEAR

4 sch	Digital Electronics (EET 1214)	3 sch	Electrical Wiring for Automation and Control Technology (MFT 1123)***
3 sch	Programmable Logic Controllers (ELT 2613)	3 sch	Oral Communications Elective
4 sch	Control Systems I (INT 2114)	3 sch	Humanities/Fine Arts Elective
3 sch	Social/Behavioral Science Elective	6 sch	Technical Electives
3 sch	Technical Elective		
17 sch		15 sch	

* Students who lack entry-level skills in math, English, science, etc. will be provided related studies.

** Mathematics course must be College Algebra (MAT 1313) or higher.

*** Commercial and Industrial Wiring (ELT 1123) may be substituted for this course.

APPROVED ELECTIVES

3 sch	Fundamentals of Drafting (DDT 1113)
3 sch	Principles of CAD (DDT 1313)
2 sch	Fundamentals of Electronics (EET 1192)
4 sch	Microprocessors (EET 1324)
3 sch	Computer Fundamentals for Electricity/Electronics (EET 1613)
3 sch	Fundamentals of Fiber Optics (EET 2423)
4 sch	Linear Integrated Circuits (EET 2334)
4 sch	Interfacing Techniques (EET 2514)
3 sch	Commercial and Industrial Wiring (ELT 1123)

3 sch Electrical Power (ELT 1213)
4 sch Solid State Motor Controls (ELT 2424)
3 sch Advanced Programmable Logic Controllers (ELT 2623)
3 sch Manufacturing Skills (IMM 1933)
3 sch Fundamentals of Instrumentation (INT 1113)
4 sch Control Systems II (INT 2124)
4 sch Calibration and Measurement Principles (INT 2214)
3 sch Automated Motion Control (MFT 2013)
3 sch Materials Requirement Planning (MFT 2113)
3 sch Statistical Process Control (MFT 2313)
3 sch Computer Integrated Manufacturing (MFT 2413)
3 sch Data Acquisition and Communications (MFT 2513)
4 sch Flexible Manufacturing Systems (MFT 2614)
1-3 sch Special Project in Automation and Control Technology [MFT 291(1-3)]
1-6 sch Supervised Work Experience in Automation and Control Technology [MFT 292(1-6)]
3 sch Fundamentals of Robotics (ROT 1113)
3 sch Industrial Hydraulics (ROT 1213)
3 sch Industrial Pneumatics (ROT 1223)
3 sch Industrial Robotics (ROT 1313)
3 sch Automated Manufacturing Controls (ROT 2413)
3 sch Servo Control Systems (ROT 2423)
3 sch Mechanical Systems (ROT 2613)
1-6 sch Work Based Learning I, II, III, IV, V, and VI [WBL 191(1-3), WBL 192(1-3), WBL 193(1-3), WBL 291(1-3), WBL 292(1-3), and WBL 293(1-3)]

Automation and Control Technology Courses

Course Name: Fundamentals of Instrumentation

Course Abbreviation: INT 1113

Classification: Career-Technical Elective

Description: This course provides students with a general knowledge of instrumentation principles. This course includes instruction in the basis of hydraulics and pneumatics and the use and testing of electrical circuits in the instrumentation process. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Demonstrate a working knowledge of instrumentation. (DOK2, STL2, STL10, STL12, STL13) a. Define terms associated with instrumentation. (DOK1) b. Discuss basic theory of hydraulics, pneumatics, and electro-magnetic controls. (DOK1) c. Identify basic symbols used with hydraulics, pneumatics, and electro-magnetic systems. (DOK1)
2. Identify the type of instrumentation input and output devices and describe their applications. (DOK1, STL2, STL13) a. Describe control elements for pressure, flow, temperature, and level. (DOK1) b. Identify the types of input and output devices. (DOK1) c. Describe the input and output devices. (DOK1)
3. Identify the types of signals used in instrumentation. (DOK1, STL2, STL9, STL13, STL17) a. Describe the transmission of information to include current, pressure, and frequency. (DOK1) b. Explain the principles of the transmission information input and output. (DOK1)
4. Describe fundamentals of process controls. (DOK1, STL2, STL9, STL13, STL19) a. Label a block diagram of an open loop system and a closed loop system. (DOK2) b. Describe characteristics of an open loop and a closed loop system. (DOK2)
5. Design a preventive maintenance program for instrumentation systems. (DOK4, STL2, STL9, STL11, STL13, STL19) a. Describe the techniques and procedures for troubleshooting, calibrating, and repairing an instrumentation system. (DOK2) b. Demonstrate the ability to sketch a piping and instrument drawing. (DOK4)

STANDARDS

ITEA Standards

STL2 Students will develop an understanding of the core concepts of technology.
STL9 Students will develop an understanding of engineering design.

Postsecondary Automation and Control Technology

STL11	Students will develop abilities to apply the design process.
STL12	Students will develop abilities to use and maintain technological products and systems.
STL13	Students will develop abilities to assess the impact of products and systems.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
A1 Numeration (ordering, place value, scientific notation)
A6 Geometry (angles, Pythagorean theory)
A8 Estimation (rounding, estimation)

21st Century Skills

CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS7 Critical Thinking and Problem Solving

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Kirk, F. W. (2005). *Instrumentation* (4th ed.). Homewood, IL: American Technical.

National Joint Apprenticeship and Training Committee. (2004). *Fundamentals of instrumentation*. Albany, NY: Thomson Delmar Learning.

Course Name: Fluid Power

Course Abbreviation: INT 1214

Classification: Career-Technical Core

Description: This basic course provides instruction in hydraulics and pneumatics. The course covers actuators, accumulators, valves, pumps, motors, coolers, compression of air, control devices, and circuit diagrams. Emphasis is placed on the development of control circuits and troubleshooting techniques. (4 sch: 3 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Define and describe basic laws governing fluids. (DOK1, STL2, STL19) a. Describe the concept of force, flow, and pressure. (DOK1) b. Analyze the relationship of force and pressure in a circuit. (DOK3) c. Explain what causes flow in a circuit. (DOK1) d. Calculate area, pressure, velocity, and rate of flow. (DOK2) e. Explain and apply the ideal gas laws, Boyle's Law and Charles' Law, in fluid systems. (DOK2)
2. Identify and draw symbols for hydraulics and pneumatics. (DOK2, STL2, STL8, STL9) a. Explain the logic for drawing symbols for hydraulic components. (DOK2) b. Draw individual hydraulic and pneumatic components. (DOK4)
3. Describe operation and nomenclature of various pumps and compressors. (DOK2, STL2, STL8, STL12, STL19) a. Analyze the operation of vane, gear, and piston pumps in hydraulics. (DOK3) b. Analyze the operation of air compressors. (DOK3)
4. Explain fluids as pertaining to the transmission of energy. (DOK2, STL1, STL2, STL16) a. Describe various types of hydraulic fluids. (DOK2) b. Explain the purpose of the fluid reservoir, the filtration system, and the heat exchanger in hydraulics. (DOK2) c. Explain the purpose of the receiver in pneumatics. (DOK2) d. Explain the purpose of trio units in compressed air. (DOK2)
5. Describe the operation of flow, pressure, and directional control valves. (DOK2, STL1, STL2, STL8, STL9, STL16) a. Explain basic design features used in each type of control valve. (DOK2) b. Demonstrate how flow, pressure, and directional valves are used in hydraulics and pneumatics. (DOK2)
6. Explain the types of actuators used in pneumatics and hydraulics. (DOK2, STL1, STL2, STL8, STL9, STL16) a. List important cylinder design features. (DOK1) b. Explain basic design features of hydraulic motors and other rotary actuators. (DOK2) c. Identify common types of air motors. (DOK1)
7. Explain, construct, and troubleshoot various hydraulic and pneumatic circuits. (DOK4, STL1, STL2, STL8, STL9, STL10, STL16)

a. Explain the purpose of a sequence circuit. (DOK2) b. Construct and troubleshoot a sequence circuit. (DOK4)
8. Demonstrate the use of electro-mechanical controls in hydraulic and pneumatic circuits. (DOK2, STL1, STL2, STL8, STL9, STL10, STL16) a. Explain the construction and use of solenoids in directional controls. (DOK2) b. Construct a hydraulic or pneumatic circuit that is controlled electrically. (DOK4)

STANDARDS

ITEA Standards

STL1	Students will develop an understanding of the characteristics and scope of technology.
STL2	Students will develop an understanding of the core concepts of technology.
STL8	Students will develop an understanding of the attributes of design.
STL9	Students will develop an understanding of engineering design.
STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
A5 Measurement (money, time, temperature, length, area, volume)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

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Course Name: Control Systems I

Course Abbreviation: INT 2114

Classification: Career-Technical Core

Description: This is an introductory course to provide information on various instrumentation components and processes. Topics include analyzing pressure processes, temperatures, flow, and level. (4 sch: 3 hr. lecture, 2 hr. lab)

Prerequisite: AC Circuits (EET 1123)

Competencies and Suggested Objectives
1. Explain and apply basic safety regulations which must be followed. (DOK2, STL5) a. Discuss required safety regulations for the lab and industrial settings. (DOK1) b. Discuss and apply safe working habits. (DOK1)
2. Describe and interpret block diagrams, instrument tags, loop drawings, and piping and instrument diagrams (P&ID). (DOK3, STL8, STL11) a. Identify symbols associated with block diagrams, instrument tags, loop drawings, and piping and instrument diagrams (P&ID). (DOK1) b. Interpret function blocks and describe their relationship to the overall process. (DOK3)
2. Describe and discuss temperature measurement devices. (DOK2, STL5, STL16) a. Discuss heat transfer. (DOK1) b. Discuss temperature measurement principles. (DOK1) c. Identify devices used to measure and control temperature. (DOK1) d. Analyze and calibrate signals from temperature measurement devices. (DOK2)
3. Describe and discuss pressure measurement devices. (DOK2, STL5, STL16) a. Identify and describe a manometer and its use. (DOK1) b. Identify and describe pressure elements and their use. (DOK1) c. Identify and describe measuring devices and their use. (DOK1) d. Analyze and calibrate pressure measurement devices. (DOK2)
4. Describe and discuss level measurement devices and their use. (DOK2, STL5, STL16) a. Identify and describe direct level measurement devices and their use. (DOK1) b. Identify and describe indirect level measurement devices and their use. (DOK1) c. Analyze and calibrate level measurement devices. (DOK2)
5. Describe flow measurement devices and their use. (DOK2, STL5, STL16) a. Identify and describe flow rate meters. (DOK1) b. Identify and describe total flow meters. (DOK1) c. Analyze and calibrate flow measurement devices. (DOK2)
6. Describe sensors used in process analysis. (DOK2, STL5, STL16) a. Discuss analyzers used in instrumentation. (DOK1) b. Describe and discuss analytical measurement fundamentals. (DOK1) c. Troubleshoot the various sensors. (DOK3)
7. Describe information transmission pertaining to process control. (DOK2, STL5, STL16) a. Discuss and describe pneumatic transmission characteristics. (DOK1) b. Explain electrical transmission characteristics. (DOK2)

c. Perform exercises to re-enforce process control concepts. (DOK2)
d. Identify various devices utilized in data information transmission. (DOK2)

STANDARDS

ITEA Standards

STL5	Students will develop an understanding of the effects of technology on the environment.
STL8	Students will develop an understanding of the attributes of design.
STL11	Students will develop abilities to apply the design process.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
A5 Measurement (money, time, temperature, length, area, volume)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

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Welcome to Wisc-Online.com. (n.d.). Retrieved March 22, 2011, from http://www.wisc-online.com/

Course Name: Control Systems II

Course Abbreviation: INT 2124

Classification: Career-Technical Elective

Description: This course is a continuation of Control Systems I with special emphasis on application of applied skills along with new skills to develop instrument process controls. The student will be given a process to develop the appropriate instruments and needed diagrams, utilizing various controlling processes and demonstrating loop troubleshooting techniques. (4 sch: 3 hr. lecture, 2 hr. lab.)

Prerequisite: Control Systems I (INT 2114)

Competencies and Suggested Objectives
1. Identify and describe parameters and variables of an operational process control system. (DOK2, STL8, STL9, STL11) a. Discuss and explain terms associated with process control instrumentation. (DOK1) b. Explain how the terms relate to the controlled process and diagrams. (DOK1) c. Describe and demonstrate different control configurations, feed forward, and cascade. (DOK2)
2. Describe control valve characteristics. (DOK2, STL8, STL9, STL11) a. Explain and demonstrate fast-opening, equal-percentage, and proportional control valves. (DOK2) b. Explain control valve positioners. (DOK1) c. Discuss and demonstrate signal conversions techniques. (DOK2) d. Apply maintenance techniques involving control valves. (DOK2)
3. Describe various modes of process control. (DOK2, STL8, STL9, STL11) a. Discuss and demonstrate on-off control. (DOK2) b. Explain and describe proportional, integral, and derivate modes of operation. (DOK2) c. Describe and demonstrate methods for tuning different control modes. (DOK2) d. Describe characteristics of each mode of operation. (DOK2) e. Connect, tune, operate, and troubleshoot various process control configurations. (DOK3)
4. Describe advanced control methods. (DOK2, STL8, STL9, STL11) a. Explain a digital control system. (DOK1) b. Discuss different levels of digital control. (DOK1) c. Describe and explain the computer's role in process control. (DOK2) d. Develop sketches of various control systems. (DOK3)
5. Troubleshoot process control loops. (DOK3, STL8, STL9, STL10 ,STL11, STL13) a. Perform standard troubleshooting techniques on process control loops. (DOK3) b. Apply safe troubleshooting techniques. (DOK3) c. Demonstrate and explain integration of system drawings. (DOK2)
6. Demonstrate procedures for handling, storing, and disposing of hazardous materials. (DOK2, STL4, STL5) a. Recognize signal words and symbols that indicate severity of a hazard. (DOK1) b. Describe methods for reducing hazardous waste. (DOK2)

c. Describe procedures for storing hazardous waste. (DOK2)
d. Interpret data found on a hazardous material safety data sheet. (DOK3)
e. Describe general safe procedures for first aid and clean-up to follow in case of an accident involving hazardous materials. (DOK2)
f. Demonstrate procedures for handling, storing, and disposing of hazardous materials. (DOK2)

STANDARDS

ITEA Standards

STL4	Students will develop an understanding of the cultural, social, economic, and political effects of technology.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL8	Students will develop an understanding of the attributes of design.
STL9	Students will develop an understanding of engineering design.
STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL11	Students will develop abilities to apply the design process.
STL13	Students will develop abilities to assess the impact of products and systems.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
A5 Measurement (money, time, temperature, length, area, volume)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving

CS9 Information Literacy

SUGGESTED REFERENCES

Bryan, L. A. (1987). *Programmable controllers: Selected applications*. Atlanta, GA: Industrial Text and Video.

Bryan, L. A. (1996). *Programmable controllers: Theory and implementation*. Atlanta, GA: Industrial Text and Video.

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

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Oaks, W. C., Leone, L. L., & Potter, M. C. (2003). *Engineering your future: A student's guide.* Wildwood, MO: Great Lakes Press.

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Course Name: Calibration and Measurement Principles

Course Abbreviation: INT 2214

Classification: Career-Technical Elective

Description: This course introduces the student to various terms related to measurement principles and calibration techniques. The topics also include the procedures and calibration of various instruments used in the industry. (4 sch: 3 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Define terms associated with measurement and calibration procedures. (DOK1, STL12) a. Describe traceability of a standard. (DOK1) b. Describe and explain static and dynamic characteristics of an instrument. (DOK1) c. Explain elevated and suppressed zero. (DOK1) d. Discuss instrument drift. (DOK1) e. Discuss units of measurement pertaining to instrumentation. (DOK1)
2. Describe a standard calibration procedure. (DOK2, STL12) a. Develop a generic calibration procedure. (DOK2) b. Perform a calibration procedure on different instrumentation apparatus. (DOK2) c. Prepare a calibration report. (DOK3)
3. Describe and perform specialized calibrations of differential pressure (DP) cells. (DOK2, STL12) a. Explain the procedures for calibrating a DP cell. (DOK1) b. Demonstrate wet leg, dry leg, pressurized vessel, elevated, and suppressed zero calibration. (DOK2)
4. Describe and demonstrate Statistical Process Control (SPC). (DOK2, STL12) a. Perform basic operations of statistics. (DOK2) b. Explain statistics and the relationship to process control instrumentation. (DOK2)

STANDARDS

ITEA Standards

STL12 Students will develop abilities to use and maintain technological products and systems.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)

R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
A5 Measurement (money, time, temperature, length, area, volume)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Cable, M. (2005). *Calibration: A technician's guide*. Research Triangle Park, NC: The Instrumentation, Systems, and Automation Society.

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

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Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

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Amatrol's Interactive Multimedia Courseware. (n.d.). Retrieved March 22, 2011, from http://www.amatrolelearning.com/lms.

Welcome to Wisc-Online.com. (n.d.). Retrieved March 22, 2011, from http://www.wisc-online.com/

Course Name: Introduction to Automation and Controls

Course Abbreviation: MFT 1112

Classification: Career-Technical Core

Description: Introduction to manufacturing/industrial technology with emphasis on safe work practices, manufacturing dynamics, use of test equipment, and fundamentals of automation and control technology. (2 sch: 1 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Explain, demonstrate, and practice general safety procedures in the shop, lab, and industrial environments. (DOK2, STL5, STL6) a. Apply proper safety techniques for all types of circuits and components. (DOK2) b. Demonstrate an understanding of and comply with relevant OSHA safety standards. (DOK2)
2. Demonstrate the proper use and operation of test equipment. (DOK2, STL5, STL6) a. Demonstrate the use and care of test instruments including volt-ohm meters, current meters, oscilloscopes, etc. (DOK2)
3. Demonstrate proficiency in the use of a calculator. (DOK2, STL2) a. Use SI symbols and prefixes to describe electrical values. (DOK2) b. Manipulate numbers in mathematical operations using scientific notation, engineering notation, and E notation to aid in mathematical circuit analysis. (DOK2) c. Perform basic algebraic operations using electronic equations to express the rules of symbol transformation. (DOK2) d. Perform practical math in solving ratio, percentage, proportions, powers, and roots of numbers on digital conversions. (DOK2)
4. Explain manufacturing dynamics. (DOK2, STL19) a. Describe the history of automated manufacturing and control systems. (DOK1) b. Identify employer goals. (DOK1) c. Identify employee responsibilities and benefits. (DOK1)
5. Demonstrate a working knowledge of instrumentation. (DOK2, STL19) a. Define terms associated with instrumentation. (DOK1) b. Discuss basic theory of hydraulics, pneumatics, and electro-magnetic controls. (DOK1) c. Identify basic symbols used with hydraulics, pneumatics, and electro-magnetic systems. (DOK1)
6. Describe the various major components of all robots. (DOK1, STL9, STL13, STL17) a. Explain the axes of movement. (DOK1) b. Label each major component. (DOK1) c. Identify four general types of work envelopes. (DOK1) d. Discuss three general forms of robot actuation. (DOK1) e. Identify different types of input devices used with robot controllers. (DOK1) f. Describe the characteristics of a robot which distinguish it from other types of automated machinery. (DOK2)

STANDARDS

ITEA Standards

STL2	Students will develop an understanding of the core concepts of technology.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.
STL9	Students will develop an understanding of engineering design.
STL13	Students will develop abilities to assess the impact of products and systems.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
A5 Measurement (money, time, temperature, length, area, volume)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

Malcolm, D. R., Jr. (1988). *Robotics: An introduction* (2nd ed.). Albany, NY: Delmar.

Mazur, G. A. (2006). *Digital multimeter principles* (4th ed.). Homewood, IL: American Technical.

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Rehg, J. A. (1992). *Introduction to robotics in CIM systems* (2nd ed.). Upper Saddle River, NJ: Prentice Hall.

Amatrol's Interactive Multimedia Courseware. (n.d.). Retrieved March 22, 2011, from http://www.amatrolelearning.com/lms.

Course Name: Electrical Wiring for Automation and Control Technology

Course Abbreviation: MFT 1123

Classification: Career-Technical Core

Description: Basic electrical wiring for automation and controls including safety practices; installation and maintenance of raceways, conduit, and fittings; and three-phase service entrances, metering devices, main panels, raceways or ducts, subpanels, feeder circuits, and branch circuits according to electrical codes. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Apply general safety rules. (DOK2, STL5, STL6) a. Explain and demonstrate safety rules and regulations for working near or on load centers and safety switches. (DOK2) b. Explain and demonstrate the ability of safe lifting and work habits. (DOK2)
2. Install and maintain raceways, conduit, and fittings. (DOK3, STL12, STL13, STL19) a. Identify types of raceways, conduit, and fittings. (DOK1) b. Apply usage of raceways, conduit, and fittings as required by electrical codes. (DOK2) c. Demonstrate the use of mechanical and hydraulic conduit benders to make specified bends to different sizes and types of conduit. (DOK2) d. Identify other types of raceways and their associated bodies. (DOK1)
3. Explain different types of three-phase service entrances, metering devices, main panels, raceways or ducts, subpanels, feeder circuits, and branch circuits according to electrical codes. (DOK2, STL12, STL13, STL19) a. Explain the codes (NEC and local) for the installation of a service entrance. (DOK1) b. Explain safety cautions to be used when installing a service entrance. (DOK1) c. Construct a sketch to install a service entrance. (DOK3) d. Explain terms associated with a service entrance. (DOK2) e. Identify components of a service entrance. (DOK1)

STANDARDS

ITEA Standards

STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.
STL12	Students will develop abilities to use and maintain technological products and systems.
STL13	Students will develop abilities to assess the impact of products and systems.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
L1 Usage (pronoun, tense, subject/verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

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Oaks, W. C., Leone, L. L., & Potter, M. C. (2003). *Engineering your future: A student's guide.* Wildwood, MO: Great Lakes Press.

Course Name: Automated Motion Control

Course Abbreviation: MFT 2013

Classification: Career-Technical Elective

Description: This course is designed to develop advanced skills in the set up of servo motion controller systems, troubleshooting and maintenance of servo motion control systems, and programming of servo motion control. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: Consent of instructor

Competencies and Suggested Objectives
1. Identify a Servo Motion Control (SMC) Systems Application in Production Mode. (DOK1, STL19) a. Run an SMC applications program. (DOK2) b. Identify SMC operating parameters. (DOK1)
2. Gather information for systems diagnosis. (DOK2, STL10, STL19) a. Gather information from the operator interface. (DOK2) b. Access and cross-reference error messages. (DOK2) c. Access on-line status. (DOK2) d. Run and trace an applications program. (DOK2)
3. Diagnose and correct a faulted application. (DOK3, STL10, STL19) a. Diagnose and reset an E-Stop condition. (DOK3) b. Upload and download program application files. (DOK2) c. Establish a desired home position post-drive train repair. (DOK2) d. Diagnose and correct an excess following/position error condition. (DOK3) e. Diagnose and correct an excess velocity error condition. (DOK3) f. Diagnose and correct an axis feedback failure condition. (DOK3) g. Diagnose, monitor, and troubleshoot discreet machine input/output devices. (DOK3) h. Diagnose, correct, and establish PLC/SMC communications. (DOK3) i. Diagnose and interpret a SMC applications program. (DOK3)

STANDARDS

ITEA Standards

STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

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Course Name: Materials Requirement Planning (MRP)

Course Abbreviation: MFT 2113

Classification: Career-Technical Elective

Description: This is a course that will develop student skills and mechanics in MRP II. Areas include resource management for productive manufacturing, development, and executing an MRP II plan, order point inventory, and closed loop systems. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: Consent of instructor

Competencies and Suggested Objectives
1. Explain the methods of managing resources of a manufacturing company more productively. (DOK2, STL10, STL19) a. Identify the role of CEO in MRP. (DOK1) b. Identify the role of Marketing in MRP. (DOK1) c. Identify the role of Manufacturing in MRP. (DOK1) d. Identify the role of Purchasing in MRP. (DOK1) e. Identify the role of Finance in MRP. (DOK1) f. Identify the role of Engineering in MRP. (DOK1) g. Lay out an MRP II data processing system. (DOK2)
2. Execute an MRP plan. (DOK3, STL10, STL19) a. Develop and implement an MRP plan within a manufacturing setting. (DOK2) b. Diagnose, monitor, and define problems within an implemented MRP plan. (DOK3) c. Establish an Order Point Inventory Model. (DOK2)
3. Collect information regarding a Closed Loop MRP. (DOK3, STL10, STL19) a. Define closed loop system. (DOK1) b. Explain materials requirements planning. (DOK1) c. Develop capacity planning and scheduling. (DOK2) d. Design and produce MRP output reports. (DOK3)

STANDARDS

ITEA Standards

STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

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Course Name: Statistical Process Control

Course Abbreviation: MFT 2313

Classification: Career-Technical Elective

Description: This course provides a detailed study of the methods of implementing and using a computer-based statistical process control system and the associated gauging and automated data collection devices. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Describe and discuss the underlying philosophy of SPC. (DOK2, STL12, STL19) a. Explain process variability. (DOK1) b. Describe the two types of variability present in all processes. (DOK2) c. Demonstrate skill to recognize terminology used in SPC. (DOK2) d. Demonstrate skill in the use of SPC statistics. (DOK2)
2. Apply SPC concepts. (DOK2, STL12, STL19) a. Configure gauging and measurements for use in automated systems. (DOK2) b. Develop control charts for manual and computer-based variables and attribute data.(DOK2) c. Interpret histograms, control charts, and other graphical data as they relate to stability in the automated manufacturing process. (DOK3) d. Develop process capability studies and interpret the resulting indices. (DOK3) e. Develop readability and repeatability (R & R) studies and interpret the results. (DOK3) f. Program and use automated data collection equipment for multi-gauge inputs with computer interfacing. (DOK3)

STANDARDS

ITEA Standards

STL12	Students will develop abilities to use and maintain technological products and systems.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Oaks, W. C., Leone, L. L., & Potter, M. C. (2003). *Engineering your future: A problem-oriented approach.* Wildwood, MO: Great Lakes Press.

Course Name: Computer Integrated Manufacturing

Course Abbreviation: MFT 2413

Classification: Career-Technical Elective

Description: This course is a study of how computers, robots, CAD/CAM, vision systems, and other automated systems can be used in computer integrated manufacturing (CIM).
(3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: Consent of instructor

Competencies and Suggested Objectives
1. Discuss the evolution and principles of CIM. (DOK1, STL1, STL3, STL13, STL19) a. Discuss the history and development of CIM. (DOK1) b. Discuss the principles and applications of CIM. (DOK1)
2. Develop a CIM application. (DOK3, STL1, STL3, STL13, STL19) a. Plan a CIM project. (DOK3) b. Implement a CIM project. (DOK3)

STANDARDS

ITEA Standards

STL1	Students will develop an understanding of the characteristics and scope of technology.
STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL13	Students will develop abilities to assess the impact of products and systems.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)

M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Data Acquisition and Communications

Course Abbreviation: MFT 2513

Classification: Career-Technical Elective

Description: This is a course in acquisition and communication of systems data in automated applications. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: Consent of instructor

Competencies and Suggested Objectives
1. Explain data communication components used in automatic systems. (DOK2, STL12, STL13, STL17) a. Identify characteristics and uses of various EIA standard data communication interfaces. (DOK1) b. Describe standard serial communications used in computers. (DOK1) c. Describe parallel communication interfaces. (DOK1)
2. Use data communication software and test the equipment. (DOK2, STL10, STL12, STL13, STL17) a. Configure computer for serial or parallel communications. (DOK2) b. Perform data transfers between computers. (DOK2) c. Use communication test equipment to troubleshoot communication links. (DOK2)
3. Use computers and/or controllers for data acquisition. (DOK2, STL12, STL13, STL17) a. Interface sensors with computer or controller for data acquisition. (DOK2) b. Write software for data acquisition application. (DOK3)

STANDARDS

ITEA Standards

STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL12	Students will develop abilities to use and maintain technological products and systems.
STL13	Students will develop abilities to assess the impact of products and systems.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
L1 Usage (pronoun, tense, subject/verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Flexible Manufacturing Systems

Course Abbreviation: MFT 2614

Classification: Career-Technical Elective

Description: This course is a production project which requires the student to apply technical skills acquired in previous courses. Project management is provided by the instructor with the students working as teams in each particular area of the manufacturing system. The students are required to plan the project and prepare the integrated system to manufacture a product. This includes all software, hardware, fixtures, clamping mechanisms, material handling requirements, sensors and interfacing, and external control devices. (4 sch: 2 hr. lecture, 4 hr. lab)

Prerequisite: Consent of instructor

Competencies and Suggested Objectives
1. Plan a project that will utilize the automated system. (DOK4, STL2, STL8, STL9, STL11, STL19) a. Develop documentation that outlines major steps in the program. (DOK4) b. Develop a process flow chart that identifies and sequences primary production steps. (DOK4)
2. Plan and specify the automation equipment required for the project. (DOK3, STL2, STL8, STL9, STL11, STL19) a. Identify the automation equipment required to support the project. (DOK3) b. Identify and list the individual process steps with supporting addresses and control data. (DOK3) c. Identify the material requirements. (DOK3)
3. Develop and program the project. (DOK4, STL2, STL8, STL9, STL11, STL19) a. Develop the initialization programming logic. (DOK4) b. Develop the input/output logic. (DOK4) c. Develop the process control logic. (DOK4)
4. Test and debug the project. (DOK3, STL2, STL8, STL9, STL10, STL11, STL19) a. Configure the automation system for the project. (DOK3) b. Troubleshoot and correct the program syntax and logic problems. (DOK3)

STANDARDS

ITEA Standards

STL2	Students will develop an understanding of the core concepts of technology.
STL8	Students will develop an understanding of the attributes of design.
STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL11	Students will develop abilities to apply the design process.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations
L1 Usage (pronoun, tense, subject/verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Special Project in Automation and Control Technology

Course Abbreviation: MFT 291(1-3)

Classification: Career-Technical Elective

Description: A course to provide students with an opportunity to utilize skills and knowledge gained in other Automation and Control Technology courses. The instructor and student work closely together to select a topic and establish criteria for completion of the project.
(1-3 sch: 2-6 hr. lab)

Prerequisite: Sophomore standing in Automation and Control Technology and/or consent of the instructor.

Competencies and Suggested Objectives
1. Develop a written plan for the special project. (DOK4) a. Compile a written plan for the special project in cooperation with the instructor which details the work to be accomplished, a schedule for delivery, and specific skills/tasks to be mastered. (DOK4)
2. Prepare a written report of activities and accomplishments. (DOK4) a. Compile a daily log of activities and tasks. (DOK4) b. Submit weekly reports to the instructor summarizing activities and tasks completed. (DOK4) c. Submit a final report of activities and experiences. (DOK4)
3. Follow written guidelines for the special project. (DOK2) a. Complete all required activities in the training program. (DOK2) b. Adhere to all written and oral instructions for the special project. (DOK2)

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.

SUGGESTED REFERENCES

Specific references for this course will depend upon the nature of the problem under investigation.

Course Name: Supervised Work Experience in Automation and Control Technology

Course Abbreviation: MFT 292(1-6)

Classification: Career-Technical Elective

Description: A course which is a cooperative program between industry and education and is designed to integrate the student's technical studies with industrial experience. Variable credit is awarded on the basis of one semester hour per 45 industrial contact hours.
(1-6 sch: 3-18 hr. externship)

Prerequisite: Consent of instructor

Competencies and Suggested Objectives
1. Apply technical skills needed to be a viable member of the workforce. (DOK2) a. Prepare a description of technical skills to be developed in the supervised work experience. (DOK3) b. Develop technical skills needed to be a viable member of the workforce. (DOK2)
2. Apply skills developed in other program area courses. (DOK2) a. Perform skills developed in other program area courses. (DOK2)
3. Apply human relationship skills. (DOK2) a. Use proactive human relationship skills in the supervised work experience. (DOK2)
4. Apply and practice positive work habits and responsibilities. (DOK2) a. Perform assignments to develop work habits and responsibilities. (DOK2)
5. Work with instructor and employer to develop written occupational objectives to be accomplished. (DOK3) a. Perform written occupational objectives in the supervised work experience. (DOK2)
6. Assess accomplishment of objectives. (DOK3) a. Prepare daily written assessment of accomplishment of objectives. (DOK3) b. Present weekly written reports to instructor in activities performed and objectives accomplished. (DOK2)
7. Utilize a set of written guidelines for the supervised work experience. (DOK3) a. Develop and follow a set of written guidelines for the supervised work experience. (DOK3)

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.

SUGGESTED REFERENCES

Specific references for this course will depend upon the nature of the problem under investigation.

Course Name: Fundamentals of Robotics

Course Abbreviation: ROT 1113

Classification: Career-Technical Elective

Description: This course is designed to introduce the student to industrial robots. Topics to be covered include robotics history, industrial robot configurations, operation, and basic programming. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Demonstrate safety procedures used in the automated environment. (DOK2, STL1, STL2, STL3, STL5, STL6) a. Apply safety rules for personal and general shop safety including eye, ear, and body protection; general rules of shop conduct; and the use of safety color coding. (DOK2) b. Apply general safety rules for tool and equipment use including hand tools, air and electric power tools, and other shop equipment. (DOK2) c. Apply general safety rules associated with working on various robotics systems. (DOK2) d. Apply rules and procedures associated with fire safety including procedures for handling and storing flammable liquids and proper use of fire fighting devices. (DOK2)
2. Describe the various major components of all robots. (DOK2, STL1, STL2, STL13, STL16, STL17, STL18, STL19) a. Explain the axes of movement. (DOK2) b. Label each major component. (DOK1) c. Identify four general types of work envelopes. (DOK1) d. Discuss three general forms of robot actuation. (DOK2) e. Identify different types of input devices used with robot controllers. (DOK1) f. Describe the characteristics of a robot which distinguishes it from other types of automated machinery. (DOK2)
3. Demonstrate the ability to operate robots. (DOK2, STL2, STL10, STL13, STL19) a. Evaluate robot performance. (DOK3) b. Apply basic programming skills. (DOK2) c. Identify and discuss end effectors. (DOK1) d. Identify and discuss visual and tactile sensors. (DOK1) e. Demonstrate basic troubleshooting techniques. (DOK2)

STANDARDS

ITEA Standards

STL1	Students will develop an understanding of the characteristics and scope of technology.
STL2	Students will develop an understanding of the core concepts of technology.

STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.
STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL13	Students will develop abilities to assess the impact of products and systems.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL18	Students will develop an understanding of and be able to select and use transportation technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Industrial Hydraulics

Course Abbreviation: ROT 1213

Classification: Career-Technical Elective

Description: This course introduces the students to basic hydraulics, hydraulic actuators, accumulators, valves, pumps, motors, fluids, coolers, and filters. Emphasis is placed on development of hydraulic control circuits and troubleshooting. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Define and describe basic laws governing liquids. (DOK1, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Describe the concept of force, flow, and pressure. (DOK1) b. Analyze the relationship of force and pressure of a circuit. (DOK3) c. Explain what causes flow in a circuit. (DOK2) d. Calculate area, pressure, velocity, and rate of flow. (DOK2) e. Explain and apply Pascal's Law in hydraulics. (DOK2)
2. Identify and draw symbols for hydraulics. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Explain the logic for drawing symbols for hydraulic components. (DOK2) b. Draw individual hydraulic components. (DOK2)
3. Describe operation and nomenclature of various pumps. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Analyze the operation of vane, gear, and piston pumps. (DOK3) b. Describe the operation of centrifugal pumps. (DOK2)
4. Explain liquids as pertaining to the transmission of energy. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Describe various types of hydraulic fluid. (DOK2) b. Explain the purpose of the fluid reservoir, filtration system, and the heat exchange in hydraulics. (DOK2) c. Illustrate the relationship of viscosity, temperature, and resistance. (DOK2)
5. Describe the operation of flow, pressure, and directional control valves. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Explain basic design features used in each type of control valve. (DOK2) b. Demonstrate how flow, pressure, and directional valves are used. (DOK2)
6. Explain the types of actuators used in hydraulics. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. List important cylinder design features. (DOK1) b. Explain basic design features of hydraulic motors and other rotary actuators. (DOK2)
7. Explain, construct, and troubleshoot various hydraulic circuits. (DOK2, STL3, STL4, STL5, STL6, STL10, STL13, STL16, STL17, STL19) a. Explain the purpose of a sequence circuit. (DOK2) b. Construct and troubleshoot a sequence circuit. (DOK3)

c. Explain the purpose of a counterbalance circuit. (DOK2)
d. Construct and troubleshoot a counterbalance circuit. (DOK3)

STANDARDS

ITEA Standards

STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL4	Students will develop an understanding of the cultural, social, economic, and political effects of technology.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.
STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL13	Students will develop abilities to assess the impact of products and systems.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Johnson, J. L. (2001). *Introduction to fluid power*. Albany, NY: Thomson Delmar Learning.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Vockroth, R. W. (1994). *Industrial hydraulics*. Albany, NY: Thomson Delmar Learning.

Course Name: Industrial Pneumatics

Course Abbreviation: ROT 1223

Classification: Career-Technical Elective

Description: This course introduces the students to basic pneumatic principles, compression of air, work devices, control devices, and circuit diagrams. Emphasis is placed on development of pneumatic control circuits, electro-mechanical control of fluid power, and troubleshooting techniques. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: Industrial Hydraulics (ROT 1213)

Competencies and Suggested Objectives
1. Define and describe basic laws governing gases. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Describe the concept of force, flow, and pressure. (DOK2) b. Analyze the relationship of force and pressure on a circuit. (DOK3) c. Explain what causes flow in a circuit. (DOK2) d. Calculate area, pressure, velocity, and rate of flow. (DOK2) e. Explain and apply Charles' Law in pneumatics. (DOK2) f. Explain and verify Boyle's Law in a circuit. (DOK2)
2. Identify and draw symbols for pneumatics. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Explain the logic for drawing symbols for pneumatic components. (DOK2) b. Draw individual pneumatic components. (DOK2)
3. Describe the operation and nomenclature of various compressors. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Analyze the operation of vane and piston pumps in pneumatics. (DOK3) b. Analyze the operation of air compressors. (DOK3)
4. Explain fluids as pertaining to the transmission of energy. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Explain the purpose of the receiver tanks, the filtration system, and the heat exchanger. (DOK2) b. Describe the purpose of pressure drops in pneumatic systems. (DOK2)
5. Describe the operation of flow, pressure, and directional control valves. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Explain basic design features used in each type of control valve. (DOK2) b. Demonstrate how flow, pressure, and directional valves are used in pneumatics. (DOK2)
6. Explain the types of actuators used in pneumatics. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. List important cylinder design features. (DOK1) b. Explain basic design features of rotary actuators. (DOK2) c. Identify common types of air motors. (DOK1)
7. Explain, construct, and troubleshoot various pneumatic circuits. (DOK2, STL3, STL4, STL5, STL6, STL10, STL13, STL16, STL17, STL19) a. Explain the purpose of a sequence circuit. (DOK2)

b. Construct and troubleshoot a sequence circuit. (DOK3)
8. Demonstrate the use of electro-mechanical controls in hydraulic and pneumatic circuits. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Explain the construction and use of solenoids in directional controls. (DOK2) b. Construct a pneumatic circuit that is controlled electrically. (DOK3)

STANDARDS

ITEA Standards

STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL4	Students will develop an understanding of the cultural, social, economic, and political effects of technology.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.
STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL13	Students will develop abilities to assess the impact of products and systems.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Johnson, J. L. (2001). *Introduction to fluid power*. Albany, NY: Thomson Delmar Learning.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Industrial Robotics

Course Abbreviation: ROT 1313

Classification: Career-Technical Elective

Description: This course teaches the operating systems and advanced programming methods of industrial robots. Actual industrial grade robots are used to train the student in the areas of operation, maintenance, troubleshooting, service procedures, and robotics applications. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: Fundamentals of Robotics (ROT 1113)

Competencies and Suggested Objectives
1. Demonstrate the ability to integrate a robot into a process. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Write programs on industrial robots to perform simulated industrial processes to operate within the confines of each robot's work envelope. (DOK3) b. Demonstrate the improvement of the efficiency of an automated robotics process by reducing cycle time, decreasing memory usage, using advanced programming techniques, etc. (DOK2)
2. Demonstrate the ability to integrate peripheral equipment. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Program and interface peripheral devices such as a programmable logic controller into robotics work cells. (DOK3) b. Interface contact and non-contact sensors into robotics work cell. (DOK2)
3. Demonstrate the ability to troubleshoot and maintain a robotics work cell. (DOK2, STL3, STL4, STL5, STL6, STL10, STL13, STL16, STL17, STL19) a. Locate and isolate faults in robotics applications. (DOK2) b. Demonstrate the use of test equipment and troubleshooting logic to repair faults. (DOK2) c. Perform routine maintenance procedures on robots with the use of checklists and service equipment (null servo valves, zero encoders, calibrate potentiometers, etc.). (DOK3)

STANDARDS

ITEA Standards

STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL4	Students will develop an understanding of the cultural, social, economic, and political effects of technology.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.

STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL13	Students will develop abilities to assess the impact of products and systems.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
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CS9 Information Literacy

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Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Automated Manufacturing Controls

Course Abbreviation: ROT 2413

Classification: Career-Technical Elective

Description: This course is designed to teach the students the integrated control systems found in automated systems. Emphasis will be placed on encoders, optical devices, servo motors, stepper motors, computerized numerical control (CNC), vision and sensing systems, lasers, programmatic controllers, motor speed controls, and other similar devices.
(3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: Industrial Robotics (ROT 1313)

Competencies and Suggested Objectives
1. Demonstrate the ability to develop a robotics process. (DOK3, STL3, STL4, STL5, STL6, STL8, STL9, STL13, STL16, STL17, STL19) a. Plan a process. (DOK3) b. Design and lay out a process. (DOK3)
2. Demonstrate the ability to interface components of a robotics process. (DOK3, STL3, STL4, STL5, STL6, STL8, STL9, STL13, STL16, STL17, STL19) a. Integrate communication links between equipment. (DOK3) b. Integrate and maintain interlock of sequential operations. (DOK3) c. Utilize contact and non-contact sensors. (DOK2) d. Integrate peripheral equipment into the process. (DOK3) e. Integrate programmable controller into the process. (DOK3)
3. Demonstrate the ability to evaluate and troubleshoot a robotics process. (DOK3, STL3, STL4, STL5, STL6, STL8, STL9, STL13, STL16, STL17, STL19) a. Evaluate system performance. (DOK3) b. Apply problem solving logic. (DOK2) c. Read and interpret schematics. (DOK2) d. Explain and operate basic test equipment. (DOK2) e. Utilize diagnostic aids. (DOK2)

STANDARDS

ITEA Standards

STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL4	Students will develop an understanding of the cultural, social, economic, and political effects of technology.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.

STL8	Students will develop an understanding of the attributes of design.
STL9	Students will develop an understanding of engineering design.
STL13	Students will develop abilities to assess the impact of products and systems.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
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CS9 Information Literacy

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Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Servo Control Systems

Course Abbreviation: ROT 2423

Classification: Career-Technical Elective

Description: This course is designed to teach servo components; servo valves; velocity servos; positional servos; force, pressure, and torque servos; servo amplifiers; programmers; and servo analysis. Emphasis is placed on servo trim and maintenance and the applications of servo systems. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Identify and discuss the components and characteristics of a servo system. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Identify the components of a basic electro-hydraulic servo system. (DOK1) b. Identify servo valves as to control type and construction. (DOK1) c. Demonstrate operating characteristics of a servo valve by conducting performance tests. (DOK2) d. Explain servo valve construction, operation, and function. (DOK2) e. Identify the types of pilot stages for servo valves. (DOK1) f. Mechanically and/or electrically null a servo valve. (DOK2) g. Test a servo valve for flow gain, saturation, and linearity. (DOK2) h. Test a servo valve for pressure gain. (DOK2) i. Demonstrate how load pressure affects flow rate. (DOK2)
2. Demonstrate the ability to construct and analyze open loop and closed loop systems. (DOK2, STL3, STL4, STL5, STL6, STL13, STL16, STL17, STL19) a. Draw a block diagram of a closed loop servo system. (DOK3) b. Identify and explain five control modes of a closed loop servo system. (DOK2) c. List and describe transducers commonly used with angular, linear, and velocity control systems. (DOK2) d. Construct and analyze open loop and closed loop velocity control systems. (DOK3) e. Construct and analyze open loop and closed loop angular position control systems. (DOK3) f. Construct and analyze open loop and closed loop linear position control systems. (DOK3) g. Demonstrate the concepts of accuracy, error, gain, response, and stability of closed loop servo systems. (DOK2) h. Construct logic diagrams and flow charts for a servo control system. (DOK3)
3. Troubleshoot and repair a servo control system. (DOK3, STL3, STL4, STL5, STL6, STL10, STL13, STL16, STL17, STL19) a. Apply troubleshooting logic to solve electrical problems with a servo control system. (DOK3) b. Apply troubleshooting logic to locate and repair a fault in the hydraulic section of an electro-hydraulic servo control system. (DOK3)

c. Construct and demonstrate an angular position control system as it relates to a simulated machine function. (DOK3)
d. Construct and demonstrate velocity control as it relates to a simulated machine function. (DOK3)
e. Construct and demonstrate linear position control as it relates to a simulated machine function. (DOK3)

STANDARDS

ITEA Standards

STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL4	Students will develop an understanding of the cultural, social, economic, and political effects of technology.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.STL10 Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL13	Students will develop abilities to assess the impact of products and systems.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Mechanical Systems

Course Abbreviation: ROT 2613

Classification: Career-Technical Elective

Description: This course introduces the students to mechanical components and drive systems commonly used in the industry. Emphasis is placed on installation, maintenance, and troubleshooting of these components and systems. (3 sch: 2 hr. lecture, 2 hr. lab)

Prerequisite: None

Competencies and Suggested Objectives
1. Describe the major components used in mechanical drive systems. (DOK2, STL3, STL5, STL13, STL16, STL17, STL19) a. Identify the mechanical components used in mechanical drive systems. (DOK1) b. Explain how individual mechanical components work. (DOK2) c. Name the parts of individual mechanical components. (DOK1)
2. Apply the principles of installation, maintenance, and troubleshooting in mechanical drive systems. (DOK3, STL3, STL5, STL10, STL13, STL16, STL17, STL19) a. Install, maintain, and troubleshoot the mechanical components of a system. (DOK3) b. Apply preventive maintenance techniques to reduce equipment failure and prevent downtime. (DOK2)

STANDARDS

ITEA Standards

STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL13	Students will develop abilities to assess the impact of products and systems.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.

Related Academic Standards

R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

21st Century Skills

CS1 Global Awareness
CS2 Financial, Economic, Business and Entrepreneurial Literacy
CS3 Civic Literacy
CS6 Initiative and Self-Direction
CS7 Critical Thinking and Problem Solving
CS9 Information Literacy

SUGGESTED REFERENCES

Ewen, P., Schurter, N., & Gundersen, E. P. (2005). *Applied physics.* Upper Saddle River, NJ: Prentice Hall.

Katz, J. R. (2000). *Keys to science success.* Upper Saddle River, NJ: Prentice Hall.

National Science Standards. (1996). Washington, DC: National Academy Press.

Oaks, W. C., Leone, L. L., & Gunn, C. J. (2004). *Engineering your future: A comprehensive approach* (4th ed.). Wildwood, MO: Great Lakes Press.

Course Name: Work-Based Learning I, II, III, IV, V, and VI

Course Abbreviation: WBL 191(1-3), WBL 192(1-3), WBL 193(1-3), WBL 291(1-3), WBL 292(1-3), and WBL 293(1-3)

Classification: Free Elective

Description: A structured work-site learning experience in which the student, program area teacher, Work-Based Learning Coordinator, and worksite supervisor/mentor develop and implement an educational training agreement. Designed to integrate the student's academic and technical skills into a work environment. Includes regular meetings and seminars with school personnel for supplemental instruction and progress reviews. (1-3 sch: 3-9 hours externship)

Prerequisite: Concurrent enrollment in career-technical program area courses

Competencies and Suggested Objectives
1. Apply technical skills and related academic knowledge needed to be a viable member of the workforce. (DOK2) a. Apply technical skills needed to be a viable member of the workforce. (DOK2) b. Apply skills developed in other related courses in a work-based setting. (DOK2) c. Perform tasks detailed in an educational training agreement at the work setting. (DOK2)
2. Apply general workplace skills to include positive work habits and responsibilities necessary for successful employment. (DOK2) a. Demonstrate pro-active human relationship skills in the work setting to include conflict resolution, team participation, leadership, negotiation, and customer/client service.(DOK2) b. Demonstrate time, materials, and resource management skills. (DOK2) c. Demonstrate critical thinking skills such as problem solving, decision making, and reasoning. (DOK2) d. Demonstrate acquiring, evaluating, organizing, maintaining, interpreting, and communicating information. (DOK3) e. Demonstrate positive work habits and acceptance of responsibilities necessary for successful employment. (DOK2)

STANDARDS

Specific standards for this course will depend upon the nature of the problem under investigation.

SUGGESTED REFERENCES

Specific references for this course will depend upon the nature of the problem under investigation.

Recommended Tools and Equipment

CAPITALIZED ITEMS

1. Analysis trainer (1)
2. CAD software (1 per computer)
3. Calibration stations (1 per 2 students)
4. Camera, video, with accessories (2)
5. CNC lathe and attachments (1)
6. CNC mill and attachments (1)
7. Computer, notebook (for programming controls) (1)
8. Computer bar-code reading systems (1)
9. Computer process control hardware (1)
10. Computer systems (1 per 2 students)
11. Conveyor system (1)
12. Dead weight tester (1)
13. Drill press, pedestal (1)
14. Educational grade robots (minimum $10,000), with end effectors (1)
15. Electromechanical trainers (1 per 3 students)
16. Flow process trainer (1)
17. Fluid power training lab trainer (1)
18. Hydraulic test kit (1)
19. MegaMeter (1 per 3 students)
20. Mechanical training lab trainer (1)
21. Meter, noise dosimeter (1)
22. Oscilloscopes (50 Mhz dual trace) (1 per 2 students)
23. Portable calibrators (2)
24. Programmable logic controller trainers with software licenses (1 per 3 students)
25. PLC simulation software
26. Robotic arm with computer software (1)
27. Robot system (SCARA type) (1)
28. Robot arm (fully articulated with computer software and programming station) (1)
29. Robot (welding with 4-9 axes) (1)
30. Special end effectors of robots (1 per robot)
31. Temperature process trainer (1)
32. Industrial grade robots (minimum $60,000), with end effectors (1)
33. Industrial pneumatics training system (1)

NON-CAPITALIZED ITEMS

1. Air compressor (5 hp) (1)
2. Automatic tool change system (1)
3. Automatic storage and retrieval system (1)
4. Basic hand tools: Pliers, wire strippers, wrenches, screwdrivers, needle-nose pliers, ruler, safety glasses (20 each)
5. Caliper, digital electronic (2)

6. Current measuring devices (1 per 2 students)
7. Digital volt-ohm-meters (1)
8. Gage, electric readout force with cable (1)
9. Gage, digametic height (1)
10. Gage, set radius (1)
11. Gauging, sets (1)
12. Networked laser printers (1)
13. Level process trainer (1)
14. Meter, air velocity (1)
15. Meter, sound octave bans analyzer (1)
16. Meter, sound level calibration (1)
17. Power tools (1/2" and 3/8" drill motors) (1 each)
18. Pressure gage repair kits (1)
19. Pressure process trainer (1)
20. Rotary actuators with powered slides systems (1)
21. Safety goggles
22. Safety devices, i.e., light curtain safety mats (1 per work station)
23. Tachometers (3)
24. Temperature meters (3)
25. Tester, datacom (1)
26. Tester, checker precision cable LE (1)
27. Vacuum, shop cleaner (1)
28. Vision system (1)
29. Vision system for CIM cell (1)

Appendix A: International Technology Education Association (ITEA) STL Content Standards[1]

STL1	Students will develop an understanding of the characteristics and scope of technology.
STL2	Students will develop an understanding of the core concepts of technology.
STL3	Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
STL4	Students will develop an understanding of the cultural, social, economic, and political effects of technology.
STL5	Students will develop an understanding of the effects of technology on the environment.
STL6	Students will develop an understanding of the role of society in the development and use of technology.
STL7	Students will develop an understanding of the influences of technology on history.
STL8	Students will develop an understanding of the attributes of design.
STL9	Students will develop an understanding of engineering design.
STL10	Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
STL11	Students will develop abilities to apply the design process.
STL12	Students will develop abilities to use and maintain technological products and systems.
STL13	Students will develop abilities to assess the impact of products and systems.
STL14	Students will develop an understanding of and be able to select and use medical technologies.
STL15	Students will develop an understanding of and be able to select and use agricultural and related biotechnologies.
STL16	Students will develop an understanding of and be able to select and use energy and power technologies.
STL17	Students will develop an understanding of and be able to select and use information and communication technologies.
STL18	Students will develop an understanding of and be able to select and use transportation technologies.
STL19	Students will develop an understanding of and be able to select and use manufacturing technologies.
STL20	Students will develop an understanding of and be able to select and use construction technologies.

[1] International Technology Education Association. (2007). *Listing of STL content standards.* Retrieved March 22, 2011, from http://www.iteea.org/TAA/PDFs/xstnd.pdf

Appendix B: Related Academic Standards[2]

Reading
R1 Interpret Graphic Information (forms, maps, reference sources)
R2 Words in Context (same and opposite meaning)
R3 Recall Information (details, sequence)
R4 Construct Meaning (main idea, summary/paraphrase, compare/contrast, cause/effect)
R5 Evaluate/Extend Meaning (fact/opinion, predict outcomes, point of view)

Mathematics Computation
M1 Addition of Whole Numbers (no regrouping, regrouping)
M2 Subtraction of Whole Numbers (no regrouping, regrouping)
M3 Multiplication of Whole Numbers (no regrouping, regrouping)
M4 Division of Whole Numbers (no remainder, remainder)
M5 Decimals (addition, subtraction, multiplication, division)
M6 Fractions (addition, subtraction, multiplication, division)
M7 Integers (addition, subtraction, multiplication, division)
M8 Percents
M9 Algebraic Operations

Applied Mathematics
A1 Numeration (ordering, place value, scientific notation)
A2 Number Theory (ratio, proportion)
A3 Data Interpretation (graph, table, chart, diagram)
A4 Pre-Algebra and Algebra (equations, inequality)
A5 Measurement (money, time, temperature, length, area, volume)
A6 Geometry (angles, Pythagorean theory)
A7 Computation in Context (whole numbers, decimals, fractions, algebraic operations)
A8 Estimation (rounding, estimation)

Language
L1 Usage (pronoun, tense, subject/verb agreement, adjective, adverb)
L2 Sentence Formation (fragments, run-on, clarity)
L3 Paragraph Development (topic sentence, supporting sentence, sequence)
L4 Capitalization (proper noun, titles)
L5 Punctuation (comma, semicolon)
L6 Writing Conventions (quotation marks, apostrophe, parts of a letter)

Spelling
S1 Vowel (short, long)
S2 Consonant (variant spelling, silent letter)
S3 Structural Unit (root, suffix)

[2] CTB/McGraw-Hill LLC. (2005). *Tests of adult basic education, Forms 7 and 8.* Monterey, CA: Author.

Appendix C: 21st Century Skills[3]

CSS1-21st Century Themes

CS1 Global Awareness

1. Using 21st century skills to understand and address global issues
2. Learning from and working collaboratively with individuals representing diverse cultures, religions and lifestyles in a spirit of mutual respect and open dialogue in personal, work and community contexts
3. Understanding other nations and cultures, including the use of non-English languages

CS2 Financial, Economic, Business and Entrepreneurial Literacy

1. Knowing how to make appropriate personal economic choices
2. Understanding the role of the economy in society
3. Using entrepreneurial skills to enhance workplace productivity and career options

CS3 Civic Literacy

1. Participating effectively in civic life through knowing how to stay informed and understanding governmental processes
2. Exercising the rights and obligations of citizenship at local, state, national and global levels
3. Understanding the local and global implications of civic decisions

CS4 Health Literacy

1. Obtaining, interpreting and understanding basic health information and services and using such information and services in ways that enhance health
2. Understanding preventive physical and mental health measures, including proper diet, nutrition, exercise, risk avoidance and stress reduction
3. Using available information to make appropriate health-related decisions
4. Establishing and monitoring personal and family health goals
5. Understanding national and international public health and safety issues

CS5 Environmental Literacy

1. Demonstrate knowledge and understanding of the environment and the circumstances and conditions affecting it, particularly as relates to air, climate, land, food, energy, water and ecosystems
2. Demonstrate knowledge and understanding of society's impact on the natural world (e.g., population growth, population development, resource consumption rate, etc.)
3. Investigate and analyze environmental issues, and make accurate conclusions about effective solutions
4. Take individual and collective action towards addressing environmental challenges (e.g., participating in global actions, designing solutions that inspire action on environmental issues)

[3] *21st century skills.* (n.d.). Washington, DC: Partnership for 21st Century Skills.

CSS2-Learning and Innovation Skills

CS6 Creativity and Innovation
1. Think Creatively
2. Work Creatively with Others
3. Implement Innovations

CS7 Critical Thinking and Problem Solving
1. Reason Effectively
2. Use Systems Thinking
3. Make Judgments and Decisions
4. Solve Problems

CS8 Communication and Collaboration
1. Communicate Clearly
2. Collaborate with Others

CSS3-Information, Media and Technology Skills

CS9 Information Literacy
1. Access and Evaluate Information
2. Use and Manage Information

CS10 Media Literacy
1. Analyze Media
2. Create Media Products

CS11 ICT Literacy
1. Apply Technology Effectively

CSS4-Life and Career Skills

CS12 Flexibility and Adaptability
1. Adapt to Change
2. Be Flexible

CS13 Initiative and Self-Direction
1. Manage Goals and Time
2. Work Independently
3. Be Self-directed Learners

CS14 Social and Cross-Cultural Skills
1. Interact Effectively with Others
2. Work Effectively in Diverse Teams

CS15 Productivity and Accountability
1. Manage Projects
2. Produce Results

CS16 Leadership and Responsibility
1. Guide and Lead Others
2. Be Responsible to Others